FIBER CEMENT FENCE SYSTEM

Related Application

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 60/451,341, filed February 28, 2003, which is incorporated by reference herein in its entirety.

Background of the Invention

Field of the Invention

[0002] This invention relates in one embodiment to fence systems, and more particularly, to a fiber cement fence system, including material formulation and methods of manufacture.

Description of the Related Art

[0003] The residential fencing industry in the United States is producing approximately 1.2 billion square feet of fences per year. This industry emphasizes fencing that is not only functional, but aesthetically pleasing as well. However, most fences are constantly exposed to the elements and can quickly lose their aesthetic appearance due to the effects of weathering and aging. This problem is particularly prevalent with fences made from wood, which account for over half of the residential fences in the United States.

[0004] It is well known that wooden fences need to be painted and maintained on a regular basis to repair the chipping and fading resulting from exposure to the elements. This frequent maintenance is both expensive and time consuming. Moreover, most wooden fences are sold in an unfinished condition and need to be painted or stained after installation to reduce the effects of exposure and bring out the true aesthetics of the fence. These processes add to the installation cost.

[0005] There are also other disadvantages associated with fences made from wood. For example, wooden fences can lose their structural integrity from continuous exposure to sun, wind, and rain. They are combustible, susceptible to termite or insect damage, and tend to rot at the ground contact area. Wood, being a product of nature, tends to have inconsistencies in appearance and structure that are generally undesirable for fencing.

For example, knots that are often present in timber fencing can cause splits and splinters in the wood, thus creating inconsistencies in the fence structure and appearance.

[0006] Moreover, currently about fifty nine percent of the wooden fences manufactured are pressure treated with Chromate Copper Arsenate (CCA), a chemical that protects the wood from degradation. However, CCA is also known to be toxic and tends to leach out of the wood over time. Alternatives to CCA have been developed, but they do not penetrate as far into the wood and tend leach out of the wood over time, which lead to less protection of the wood.

[0007] To address these problems, plastic fences, plastic wraps around wood, and plastic components have been developed to improve the durability of residential fences. In addition to plastics, vinyl and fiberglass have also been used as material for fencing. However, plastic and vinyl fences are also known to degrade due to exposure to ultraviolet light. Moreover, fences made out of plastic, vinyl, and fiberglass are much less aesthetically appealing because they do not have a natural look similar to wood.

[0008] Hence from the foregoing, it will be appreciated that there is a need for a fence system that is durable, aesthetically appealing, and resembles natural wood. To this end, there is a particular need for a residential fence system that is easy and inexpensive to manufacture, requires low maintenance, does not degrade rapidly upon exposure to the elements, does not require pressure treatment, has a consistent finish and yet simulates the finish of standard fencing materials such as timber or masonry.

Summary of the Invention

[0009] In one aspect, the preferred embodiments of the present invention provide a fence system comprising a mounting surface and a plurality of individual members that are attached to the mounting surface and aligned in a manner so as to form a barrier. The at least one individual member preferably comprises fiber cement and is made into a desired shape for use in a fence prior to curing of the fiber cement. Preferably, the at least one individual member does not exhibit any fraying of the fibers along surfaces of the at least one individual member after curing. The at least one individual member preferably resembles a picket, such as a wooden picket, and includes at least one surface that has a pre-finish thereon.

[0010] In one embodiment, the at least one individual member has a first end, the first end being formed into a shape selected from the group consisting of square cut, dog-eared, French gothic, scalloped, pointed and saw-toothed. In another embodiment, the at least one individual member includes a first surface having a finish that resembles wood or masonry. The first surface can comprise two opposing sides of the at least one individual member. The fiber cement forming the individual member, in some embodiments, incorporates a low density additive such as microspheres or volcanic ash. The fibers incorporated into the fiber cement can comprise moisture resistant cellulose fibers, biocide treated cellulose fibers, or dispersible cellulose fibers. Moreover, the mounting surface of the fence system preferably has a longitudinal axis, and the at least one individual member is positioned in a manner such that a longitudinal axis of the individual member is substantially perpendicular to the longitudinal axis of the mounting surface. The mounting surface can be a rail made of wood, fiber cement or other suitable materials.

[0011] In another aspect, the preferred embodiments of the present invention provide a fence system comprising a mounting surface and a plurality of individual members that are attached to the mounting surface and aligned in a manner so as to form a barrier. The at least one individual member preferably comprises fiber cement and is made into a desired shape for use in a fence prior to curing of the fiber cement. In certain embodiments, the at least one individual member is formed of a plurality of fiber cement layers and does not exhibit any substantial visible separation of the layers. Preferably, the at least one individual member resembles a picket and includes at least one surface that has a pre-finish thereon. In one embodiment, the at least one individual member has at least one surface that is embossed with a pattern. Preferably, the at least one individual member has a first end, the first end being formed into a shape selected from the group consisting of square cut, dog-eared, French gothic, scalloped, pointed, and saw-toothed.

[0012] In yet another aspect, the preferred embodiments of the present invention provide a method of forming a fiber cement fence component. The method comprises providing a fiber cement article having a first and a second surface and forming a pattern on the first and second surfaces of the fiber cement article. In one embodiment, the pattern is formed using a plurality of rollers, wherein each roller has a textured surface and is adapted

to turn at a predetermined speed relative to the fiber cement article to achieve a high fidelity transfer of the pattern to the first and second surfaces of the fiber cement article. In another embodiment, the pattern is formed using a plurality of rollers, wherein each roller has a surface and is adapted to turn at a predetermined speed relative to the fiber cement article so as to smoothen and planarize the first and second surfaces of the fiber cement article. Preferably, the pattern is formed on the first and second surfaces substantially simultaneously.

[0013] The method further includes cutting the fiber cement article into a plurality of members of pre-selected shapes and dimensions prior to curing the fiber cement article. Preferably, the shapes and dimensions are configured such that at least one of the members resembles a picket. In one embodiment, each of the members has a first end that is formed into a shape selected from the group consisting of square cut, dog-eared, French gothic, scalloped, pointed and saw-toothed. The method continues with curing the individual members of the fiber cement article to form the fiber cement composite fence component.

[0014] In yet another aspect, the preferred embodiments of the present invention provide a picket for a fence, wherein the picket is made of a fiber cement material and the fiber cement being made into a desired shape for use as the picket prior to curing of the fiber cement. Preferably, the picket does not exhibit any substantial fraying of the fibers along surfaces after curing. Preferably, the picket can be nailed onto a fence rail. In one embodiment, at least one exterior surface of the picket includes a pre-finish thereon, such as painted to resemble the color of wood. In some embodiments, the at least one exterior surface of the picket can comprise two opposing sides of the picket. In another embodiment, at least one exterior surface of the picket is stained or textured to resemble wood, or has a surface finish that resembles masonry.

[0015] In yet another aspect, the preferred embodiments of the present invention provide a fence system comprising a plurality of pickets each having an elongate configuration extending between an upper end and a lower end. Each picket is made of fiber cement and formed into a desired shape, sized and configured for use in a fence prior to curing of the fiber cement. Preferably, the pickets after curing do not exhibit any substantial fraying of the fibers along surfaces of the pickets. Preferably, the pickets are installed

generally perpendicular to a ground surface and in substantially parallel relationship to one another. In one embodiment, each picket is formed of a plurality of layers and the pickets do not exhibit any substantial visible separation of layers. In some embodiments, each of the pickets has an aspect ratio of between 4 and 12, a length between about 6 and 8 feet, a width between about 4 and 12 inches, and a thickness of between about 5/16 and ¾ inch. Preferably, each of the pickets is spaced apart from one another by a distance of between about ½ and 1 inch. Preferably, each of the pickets has a pre-finish thereon. In certain embodiments, the fence system further comprises a pair of mounting rails, each extending substantially perpendicular to the pickets. Preferably, a first mounting rail is secured to the pickets at an upper location of the pickets, and a second mounting rail is secured to the pickets along a lower location of the pickets. In some embodiments, the fence system further comprises at least two posts, each of the posts having an elongate configuration extending between an upper end and a lower end and being substantially parallel to the pickets. Preferably, the posts are secured to the mounting rails, wherein the lower ends of the posts extend below the lower ends of the pickets to secure the posts in a ground location.

[0016] In yet another aspect, the preferred embodiments of the present invention provide a method of forming a fence component. The method comprises providing an uncured article comprising fiber cement, forming at least one fence component from the uncured article, the fence component having a shape configured to be used as a fence picket, and curing the at least one fence component to form at least one fence picket. In certain embodiments, the at least one fence component has a substantially rectangular traverse cross-section, a length between about 6 and 8 feet, an aspect ratio of between about 9 and 12, a width between about 4 and 12 inches, and a thickness between about 5/16 and ¾ inch. Preferably, the at least one fence component has a pre-finish thereon. Preferably, a plurality of fence components are formed from the uncured article and the fence components are formed by cutting at least one fence component from the uncured article. The at least one fence component preferably has a front surface, a back surface, and a pair of sides adjoining the front and back surfaces. The method comprises applying a pattern to at least one of the surfaces prior to curing the article. In one embodiment, the method comprises applying the

pattern simultaneously to both surfaces, which can be achieved by using a plurality of embossing rollers.

[0017] In yet another aspect, the preferred embodiments of the present invention provide a method of constructing a fence. The method comprises providing a plurality of fiber cement pickets, each of the pickets being formed into its substantially finished shape prior to curing of the pickets and installing the fiber cement pickets at a desired fencing location, the pickets being installed in substantially parallel relationship with respect to each other, to form a desired barrier between opposite sides of the barrier. In one embodiment, the method comprises mounting the pickets adjacent to a mounting surface, such as two substantially parallel fence rails, by nailing the pickets to the rails. In certain embodiments, the fiber cement pickets can be installed adjacent conventional wooden pickets to replace damaged wooden pickets.

[0018] Preferably, each of the pickets has a length of between about 6 and 8 feet and a width of between about 4 and 12 inches. In certain embodiments, each of the pickets has an aspect ratio of between 10 and 11. Preferably, each of the pickets is spaced apart from one another by a distance of between about ½ and 1 inch. Moreover, in some embodiments, each of the pickets includes at least one surface that has a pre-finish thereon and/or is embossed with a design.

[0019] In yet another aspect, the preferred embodiments of the present invention provide an elongate member made of fiber cement, wherein the elongate member in its uncured state is sized and configured for use as a picket for a fence. In one embodiment, a first end of the elongate member has a dog-eared shape, which is formed in the elongate member in its uncured state. In another embodiment, the elongate member has at least one surface that has a pre-finish thereon.

[0020] In yet another aspect, the preferred embodiments of the present invention provide a fence picket, comprising an elongate member made of fiber cement sized and configured for use as a fence picket. The elongate member preferably has a length defined between an upper end and a lower end, a front surface and a back surface, and substantially parallel sides adjoining the front surface and back surface, wherein at least one of the surfaces has a pre-finish thereon. In one embodiment, the fence picket has a length of between about

2 and 10 feet and a width of between about 4 and 12 inches. In another embodiment, the upper end of the fence picket is shaped with a design selected from the group consisting of square cut, dog-eared, French gothic, scalloped, pointed, and saw-toothed. In another embodiment, the front surface of the fence picket has a pattern impressed, imprinted, inscribed, or painted. In yet another embodiment, the front surface of the fence picket has a pattern that is substantially smooth. In yet another embodiment, the front surface of the fence picket has a pattern that resembles wood.

Brief Description of the Drawings

[0021] FIGURE 1A is a schematic illustration of a fiber cement fence system of one embodiment of the present invention;

[0022] FIGURE 1B is a schematic illustration of a fiber cement fence cement of another embodiment, showing a side-by-side good neighbor fence system;

[0023] FIGURE 1C is a schematic illustration of a top view of a fiber cement fence system of yet another embodiment, showing a board-on-board fence system;

[0024] FIGURE 2A is a schematic illustration of a fiber cement picket of one preferred embodiment of the present invention;

[0025] FIGURES 2B and 2C are schematic illustrations of patterns and textures formed on opposing faces of a fiber cement picket of the fence systems illustrated in FIGURE 1;

[0026] FIGURE 3 shows a plurality of designs that can be formed on the upper and/or lower ends of the fiber cement pickets of FIGURE 1;

[0027] FIGURE 4 illustrates a preferred process of manufacturing a fiber cement picket.

Detailed Description of the Preferred Embodiment

[0028] Preferred embodiments of the present invention disclose a novel fence system and methods of manufacture that utilize the advantageous properties of fiber cement to produce a durable fence system that is resistant to rot, burn, moisture, ultraviolet light, insect damage and yet can be made to resembles natural wood, masonry, or any other type of natural finish.

[0029] References will now be made to the drawings wherein like numerals refer to like parts throughout. Figure 1A provides a schematic illustration of a fence system 100 of one embodiment of the present invention. As shown in Figure 1A, the fence system 100 generally resembles a typical wooden picket fence. The fence system 100 comprises two posts 110 separated by a first distance 112 and a plurality of rails 120, preferably two rails 120 as illustrated, extending between the posts 110 serving as a mounting surface for a plurality of elongate members 130 aligned along the first distance 112.

[0030] As Figure 1A further illustrates, each post 110 is preferably supported by a footer 140 made of concrete or other suitable material. The posts 110 are anchored in the ground in accordance with standard building practices and provide support for the rails 120. The rails 120 are fixedly attached to the posts, preferably with fasteners such as nails, staples, screws or other suitable means, which in turn provide a mounting surface for the elongate members 130. Preferably, the rails 120 are substantially perpendicular to the posts 110 and are generally parallel to the ground, while the posts 130 are substantially parallel to one another and perpendicular to the ground. When a pair of rails is provided, an upper rail may be secured at an upper location of the elongate members, and a lower rail may be secured at a lower location of the elongated members. In one embodiment, the elongate members 130 are mounted on the rail 120 in a manner such that each elongate member 130 is separated from adjacent elongate members 130 by a second distance 114 so as to resemble pickets of a picket fence. The second distance 114 may be, for example, between ½ inch to 1 inch.

[0031] In another embodiment as shown in Figure 1B, the elongate members 130 are mounted on the rails 120 in a manner such that each elongate member 130 is in direct contact with adjacent elongate members 130 so as to form a continuous fence panel comprised of separate, discrete members. Each of the elongate members is preferably substantially parallel to one another. The elongate members 130 can be attached to the rails 120 with fasteners such as nails, staples, screws, or other suitable means, and may preferably be attached such that they are generally perpendicular to the rails 120. As shown in Figure 1B, the fence system 100 resembles a typical wooden side-by-side good neighbor fence system in which the fiber cement pickets 130 are positioned immediately adjacent one another so as to form the appearance of a plurality of boards 122 joined together.

[0032] Figure 1C is a top view of a fiber cement fence system 100 of yet another embodiment, which resembles a typical wooden board-on-board fence system. In this embodiment, the fiber cement pickets 130 are mounted to the rails 120 in a manner such that the pickets 130 alternate between opposing surfaces of the rails 120. In the descriptions herein below, the elongate members 130 will be referred to as pickets. It will be appreciated that the term "picket" is a broad term and is used in its ordinary meaning and is intended to include any elongate members that are suitable for forming barrier structures in a fence system, including but not limited to any elongate members that do not have a pointed or sharpened end.

[0033] In one embodiment as shown in Figure 2A, each elongate member 130 or picket generally has an upper end 140, a lower end 142, a front surface 144, a back surface 146, and a pair of sides 148a, 148b adjoining the front surface and back surface. The pickets preferably each have a substantially rectangular traverse cross-section. The dimensions of the elongate members are preferably selected to correspond with desired dimensions of fence pickets. In one embodiment, the pickets have a length between about 3 and 12 feet, more preferably between about 6 and 8 feet. In one embodiment, the pickets have a width between about 4 and 12 inches, more preferably between about 6 and 8 inches. In one embodiment, the pickets have a thickness between about 5/16 and 3/4 inch, more preferably between about 7/16 and 1/2 inch. An aspect ratio is defined for each picket as the length to width ratio of the picket, and is preferably between about 4 and 12, more preferably between about 9 and 12, more preferably between about 10 and 11.

[0034] In a preferred embodiment, the posts 110, rails 120 and pickets 130 are all made from fiber cement. Alternatively, in another embodiment, only pickets 130 are made from fiber cement. Fiber cement provides the fence system with durability and favorable properties such as resistance to rot, burn, moisture, ultraviolet light, and insect damage. Moreover, fiber cement is generally less expensive, has a more consistent surface finish, and does not require pressure treatment required by conventional wooden fencing materials. In some embodiments, the posts 110 and rails 120 can be made of, but are not limited to, wood, steel, PVC, or other suitable material.

[0035] Figures 2B and 2C provide a detailed view of a fiber cement picket 130 of a preferred embodiment of the fencing system. The picket 130 has an elongate configuration and preferably has a clean cut along its side surfaces 132. More preferably, the picket 130 shows no substantial visible delamination and its edges 132 are substantially uniform, smooth and non-frayed. As will be described in greater detail below, the pickets 130 of certain preferred embodiments are formed in a manner such that the side surfaces of each picket are smooth, uniform and do not show any substantial visible delamination and/or fraying that are often present in saw-cut fiber cement panels. Typically, when cured fiber cement panels are saw-cut, fraying and visible delamination between fiber cement layers are apparent, particularly in fiber cement panels made by the Hatscheck process.

[0036] As also shown in Figures 2B and 2C, a pattern can be formed on opposing surfaces 210, 230 of the fiber cement picket 130. The term "pattern" or "pre-finish" as used herein are broad terms and are intended to have their ordinary meanings and to include any pattern, texture, painting or other pre-finishing on a surface of the picket, which may include a smooth surface or textured surface. The pattern on the surfaces 210, 230 may resemble that of timber, brick, masonry, or other geometric or random patterns. In addition to the patterns, the fiber cement pickets can also be finished to resemble natural timber, brick, or masonry. While the appearance of the pickets preferably resembles natural wood or masonry, the pickets are formulated with a fiber cement material so that it is in fact lighter, stronger and more durable than fences made from natural wood or masonry. As will be described in greater detail below, these patterns are formed on the surfaces of the fiber cement pickets using man-made processes that are designed to create consistent and repeatable patterns so that the appearance of the fence is not affected by variations in the quality of the raw material.

[0037] The fiber cement pickets 130 can be formed in a variety of different configurations. Figure 3 shows some of the configurations that the fiber cement pickets 130 can be formed to resemble the shapes and designs of various conventional wooden pickets. As shown in Figure 3, one or both ends of the fiber cement picket 130, and preferably an upper end, can be formed into a variety of shapes such as square cut configuration 300, dog-eared 310, French gothic 320, scalloped 330, pointed 340, saw-toothed 350, or other suitable

designs. These configurations in combination with the finish and patterns formed on the opposing surfaces of the picket provide a ready-made fiber-cement picket that resembles wood or other conventional pickets and can be conveniently installed without requiring additional painting, staining, or pressure treatment.

[0038] In one embodiment, the fiber cement pickets 130 can be easily mounted to the rails 120 by using conventional nailing, stapling, or screwing methods. This permits the use of these fiber cement pickets as a ready replacement for wooden pickets on existing fence systems. The fiber cement pickets can be simply nailed, screwed, or stapled onto existing fence rails without the need of specially made fasteners, brackets, or the like as required by most non-wood fence systems. Moreover, the fiber cement pickets 130 can be formed in a variety of different dimensions. In one embodiment, the length of the fiber cement picket 130 is between about 3 to 12 feet, the width is between about 4 to 12 inches, and the thickness is between about 5/16 to ¾ inch.

Fence Material Formulation

[0039] One preferred formulation of the material used to form a fiber cement fence system, including the fiber cement pickets, generally comprises a cementitious binder, an aggregate, fibers, low-density additives, and other additives to improve different material properties. It will be appreciated that not all of these components are necessary to formulate a suitable fiber cement fence system, and thus, in certain embodiments, the formulation simply comprises a cementitious matrix and fibers.

[0040] The cementitious binder is preferably Portland cement but can also be, but is not limited to, high alumina cement, lime, high phosphate cement, and ground granulated blast furnace slag cement, gypsum plasters, or mixtures thereof.

[0041] The aggregate is preferably ground silica sand but can also be, but is not limited to, amorphous silica, micro silica, geothermal silica, diatomaceous earth, coal combustion fly and bottom ash, rice hull ash, blast furnace slag, granulated slag, steel slag, mineral oxides, mineral hydroxides, clays, magnasite or dolomite, polymeric beads, metal oxides and hydroxides, or mixtures thereof.

[0042] The fibers are preferably cellulose wood pulp but can also be, but is not limited to, ceramic fibers, glass fibers, mineral wool, steel fibers, and synthetic polymer

fibers such as polyamides, polyesters, polypropylene, polymethylpentene, polyacrylonitrile, polyacrylamide, viscose, nylon, PVC, PVA, rayon, glass ceramic, carbon or any mixtures thereof. The fibers of preferably cellulose pulp can be treated with a hydrophobic agent such as silane, but can also be treated with, but is not limited to, silane derivatives, alkoxylsilane, epoxy organosilane, and alkylalkoxylsilane. In some embodiments, the fibers comprise cellulose fibers that are predominantly individualized fibers with partial or complete removals of lignin components from the fiber cell walls.

[0043] The low density additives are preferably volcanic ash or hollow aluminosilicate microspheres but can also be, but is not limited to, calcium silicates or calcium silicate hydrates, diatomaceous earth, expanded perlite, vermiculite, expanded shale or any mixtures thereof.

[0044] The other additives can include, but are not limited to, silica fume, geothermal silica, fire retardants, viscosity modifiers, thickeners, pigments, colorants, plasticisers, dispersants, foaming agents, flocculating agents, waterproofing agents, organic density modifiers, aluminum powder, kaolin, alumina trihydrate, mica, metakaolin, calcium carbonate, wollastonite, polymeric resin emulsions, drainage aids, wet and dry strength aids, silicone materials, clay, or mixtures of thereof.

[0045] One example of a fiber cement fence system composition can include a low-density additive such as volcanic ash and can be encompassed by the following formulation:

- about 5%-80% cementitious binder such as Portland cement;
- about 0%-80% aggregate such as silica;
- about 4.1%-15% fibers such as cellulose fibers;
- about 2%-50% volcanic ash;
- about 0%-10% additives.

[0046] Another example of a fiber cement fence system composition can include a low-density additive such as microspheres and can be encompassed by the following formulation:

- about 5%-80% cementitious binder such as Portland cement;
- about 0%-80% aggregate such as silica;

- about 4.1%-15% fibers such as cellulose fibers;
- about 2%-90% microspheres;
- about 0%-10% additives.

[0047] Advantageously, the incorporation of low-density aggregates in the fiber cement picket produces a lightweight fence system that can be easily transported and installed. Moreover, the incorporation of hydrophobic and/or biocide treated fibers provides the fence system with superior moisture and insect resistant properties. In some embodiments, the fiber cement composition can also be adjusted to tailor to specific properties, such as strength, durability, or dimensional stability, desired in the fence system. For example, the composition can incorporate low density additives and/or engineered fibers disclosed in U.S. Patent Nos. 6,572,697, 6,676,745, 6,676,744 and Applicant's copending U.S. Patent Applications Nos. 09/970,389, 09/969,964, 10/090,060 the entirety of each of the above-referenced reference is hereby incorporated by reference.

[0048] The material may be formed into a green shaped article from a waterborne mixture or slurry by a number of conventional processes as would be known to one of skill in the art. The processes include but are not limited to:

- Hatschek sheet process;
- Mazza pipe process;
- Magnani process;
- Injection molding;
- Extrusion;
- Hand lay-up;
- Molding;
- Casting;
- Filter pressing;
- Flow on machine;
- Roll forming, etc. with or without post pressing.

[0049] In one embodiment, the Hatschek sheet process used is preferably that described in Australian Patent No. 515151 and U.S. Patent No. 6,030,447, which are hereby incorporated by reference.

[0050] The green shaped article is preferably pre-cured for up to about 80 hours, more preferably about 24 hours or less, to establish the formulation to set. The material is then air cured, preferably for about 28 days or more preferably, autoclaved at an elevated temperature and pressure in a steam saturated environment at about 120 to 180 degrees C for about 3 to 30 hours, more preferably about 24 hours or less. It will be appreciated that the length and time chosen for curing is dependent on the formulation, the manufacturing process, and the form of the article.

Process of Manufacturing a Fiber Cement Picket

[0051] Figure 4 illustrates a preferred process of manufacturing a fiber cement picket. As Figure 4 shows, the process begins with step 410 in which fiber cement green shaped articles or sheets are received from a forming machine. In one embodiment, the forming machine is configured to produce a moldable fiber cement green sheet using a slurry dewatering manufacturing process, such as, but not limited to, the Hatschek process.

[0052] In Step 420, one or more patterns are applied to the green sheet using methods to be described in greater detail below. In one embodiment, the patterns are applied simultaneously to opposing surfaces of the green sheet. The patterns can be simultaneously applied to both sides of the sheet by passing the sheet between two embossing rollers. In one embodiment, the rollers are made of mild or hardened steel. The diameter of the rollers is preferably between about 7.5 inches – 19.1 inches. Each roller has a textured surface and is adapted to turn at a predetermined speed relative to the green sheet to achieve a high fidelity transfer of the patterns/textures to the green sheet. In some embodiments, at least one of the rollers has a substantially smooth surface and is adapted to turn at a predetermined speed relative to the green sheet to smoothen and planarize the surfaces of the green sheet. The rollers preferably operate at between 0 to about 400 feet per minute (fpm), more preferably about 150-325 fpm, and at a pressure of between 0 to about 40,000 pounds. The patterns can resemble the appearance of timber, brick, masonry, or other geometric or random patterns. Advantageously, Step 420 is designed to quickly and efficiently apply patterns simultaneously to both surfaces of a plurality of fiber cement pickets.

[0053] As Figure 4 further shows, in Step 430, the green sheet is cut down into predetermined widths of the individual pickets. In one embodiment, the green sheet is cut

into pickets by cutting means such as a water jet. Cutting may also be done using a rotating blade, a guillotine saw, or a punch device.

[0054] In Step 440, it is determined whether the picket will have a design such as square cut, dog-eared, French gothic, scalloped, pointed or saw-toothed. If a design is designated for the pickets, the design will be cut into the picket's upper and/or lower ends in Step 450 while the picket is being cut to length. The picket can be cut using processes and/or tools such as a water jet, drop (guillotine) saw, or a punch. Preferably, cutting of the picket design and length are performed simultaneously via a water jet cutter. If no design is designated for the pickets in Step 440, the process directly proceeds to Step 460 in which the pickets are cut to length, using a water-jet cutter or the like, with straightedge ends and proceed through the process. Because the pickets are cut in the green state, the edges are generally smoother and more uniform than pickets that are cut after the fiber cement is cured.

[0055] In Step 470, the green sheet pickets are transported down a conveyor and stacked via a vacuum system onto the pallet stacks. In Step 480, the fiber cement pickets are precured in ambient temperatures, preferably for no more than 24 hours, and then preferably placed in an autoclave of temperature of about 180°C and pressure of about 125 psi for about 12 hours.

[0056] As Figure 4 also shows, in Step 490 of the process, the pickets are mechanically removed from the stacks and put through a machine in which a finish/stain is applied to all surfaces of the picket. The pickets are then run through a line of heaters to dry the finish. In one embodiment, the finish is a water based acrylic stain and can be applied in a variety of ways. Some examples include, but are not limited to, vacuum coating, brush coating, pneumatic coating, spraying the picket, dunking the picket, soaking, curtain coating, or flood coating. After the finish is applied to the pickets, the finished pickets are replaced on wooden pallets and wrapped in Step 500. It will be appreciated that the above methods can also be used to form various other components of the fence system, including but not limited to, fence posts and rails.

[0057] In one embodiment, the above described fence system can be installed by securing a plurality of fiber cement picket to a mounting surface in a manner such that the pickets are installed in substantially parallel relationship with respect to each other to form a

desired barrier between opposite sides of the barrier. Preferably, the mounting surface comprises two rails that extend parallel to each other and supported by two posts. Each picket can be nailed, stapled, or otherwise mounted to the rails. In some embodiments, a single fiber cement picket can be mounted adjacent wooden pickets to replace broken or damaged conventional wooden pickets in existing fence systems.

[0058] The posts can be first mounted in footers positioned in the ground, following by securing at least two rails to the posts such that the rails extend between the posts. The individual pickets can then be secured to the posts. In one embodiment, the individual pickets are secured to and supported by the posts such that the pickets are not in substantial contact with the ground surface. In another embodiment, a lower end of the individual pickets can be planted in the ground for additional support. Preferably, the pickets are installed generally perpendicular to the ground surface and in substantially parallel relationship to one another.

[0059] The preferred embodiments of the present invention provide a fence system that has the appearance of wood, but is much more durable, less combustible, and easier to maintain as compared to wood. The preferred embodiments also provide a method to apply a pattern, such as color or texture, to opposing surfaces of a fiber cement fence without having to put two planks of fiber cement back to back. Moreover, the fiber cement fence system provides a pre-finished fence picket that requires no painting or staining during installation. Another advantage is that the fiber cement fence pickets are made of a dimensionally stable and durable material. The fiber cement pickets have clean, smooth and non-frayed or delaminated edges and side surfaces. The fiber cement picket is insect resistant and has improved durability for ground contact. The fiber cement fence system reduces maintenance for upkeep of the fence. Furthermore, the system is easy to assemble and can be installed using traditional material such as nails and does not require additional brackets or complex assembly systems. The fiber cement pickets of the preferred embodiments can be used to replace damaged wooden pickets in existing fence systems as well as form part of fiber cement fence systems.

[0060] Fiber cement pickets of the preferred embodiments are also advantageously made into a desired shape for use in a fence prior to curing of the fiber

cement. Cutting the fiber cement pickets into size and shape prior to curing provides a final product that does not exhibit any substantial fraying of the fibers along the surfaces of the picket. If fiber cement panels are cut after curing, side surfaces of the panels that have been exposed to the cutting device typically exhibit fraying of the fibers. In some cases in which the fiber cement panels are made by the Hatschek process, delamination between the fiber cement layers often occurs when the panels are cut after curing. Advantageously, the fiber cement pickets of the preferred embodiments provide a picket that does not have any of the disadvantageous features associated with fiber cement pickets cut into shape after the fiber cement is cured.

[0061] Although the foregoing description of the preferred embodiment of the present invention has shown, described and pointed out the fundamental novel features of the invention, it will be understood that various omissions, substitutions, and changes in the form of the detail of the apparatus as illustrated as well as the uses thereof, may be made by those skilled in the art, without departing from the spirit of the invention.